SERVICES POSTED TO WORKING GROUP

SEPTEMBER 21, 1999

MECHANICS MEETING

E. ANDERSSEN, LBNL

Pixel Detector

Module/Power supply Parameters

	Voltage		Current		Line Drop		Type I	Type II	Type III	Type IV	Type V	Pigtail
Power Supply	*Max*	*Nominal*	*Max*	*Nominal*	*Allowed*	*Worst Case*	*Actual*	*Actual*	*Actual*	*Actual*	*Nominal*	*Nominal*
VDD	6.000	4	2	1.52	2	2.067	0.415	0.376	0.272	0.554	0.200	0.250
VDDA	6.000	3.5	1.2	1.08	2	1.942	0.295	0.267	0.303	0.626	0.200	0.250
VCCA	4.000	1.75	1.5	1.44	2	1.982	0.393	0.357	0.258	0.525	0.200	0.250
VVDC	-	4	-	0.1	-	1.490	0.207	0.746	0.028	0.058	0.200	0.250
VPIN	-	10	-	0.0005	-	-	-	-	-	-	-	-
ISET0	-	-	-	-	-	-	-	-	-	-	-	-
ISET1	-	-	-	-	-	-	-	-	-	-	-	-
RESET	-	-	-	-	-	-	-	-	-	-	-	-
VDET	-	700	0.004	-	-	-	-	-	-	-	-	-

- **Numbers used to size cables are for worst case at the end of life**
  - Assume this is correct until further notice
- **Current quoted above is for Two modules in parallel (power supply)**
  - B-Layer modules may have more dissipation and use different table/cable sizes
- **Cable Performance requirements have not been considered**
  - EMI more work than anticipated
  - Active or Passive Elements at PP2 or PP3 are not ready for primetime
  - Connectors only selected to first order
- **Round/Twisted/Untwisted**
  - Will purchase and prototype each
  - Have laid in twisted out to PP3 (most space)

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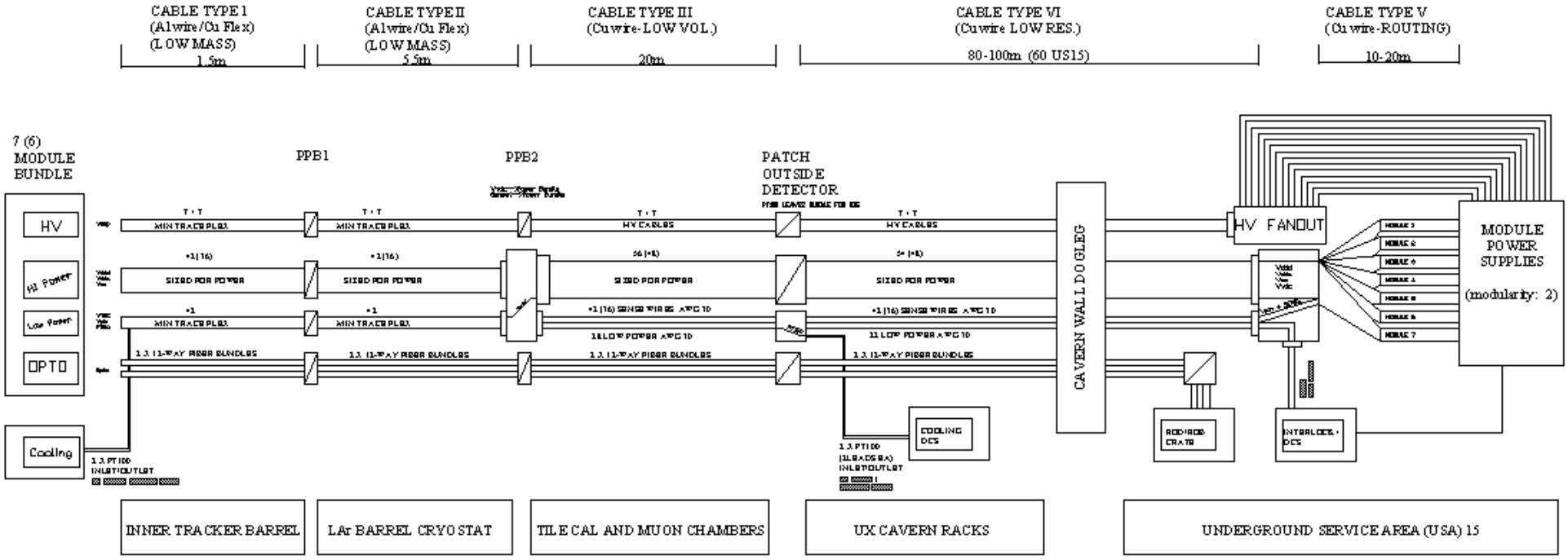
Cable Plant

- Design to integrate bundles well with Structure/Modularity
- Cables sized based on local optimizations, e.g. mass, voltage drop for a given region
- Overall Voltage Drop limited to 2.0V
- PP3 introduced to allow for jump to larger size for long run



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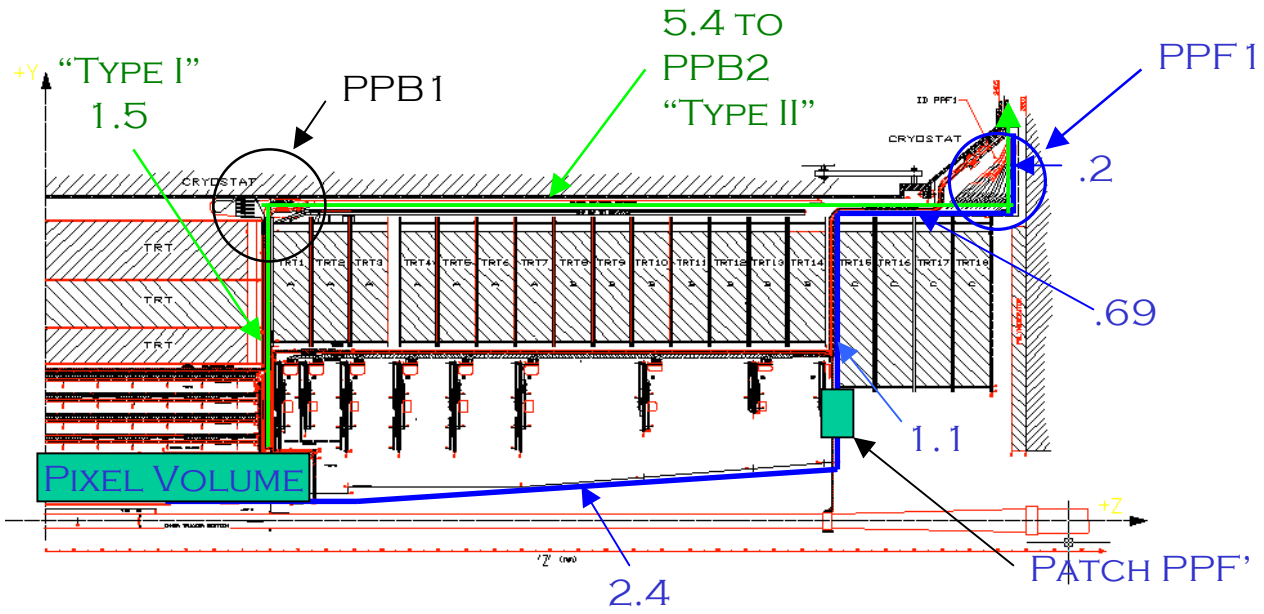
B-Layer Services are Different



B-Layer routing is shown in Blue, the rest of the Pixel services are routed along the green path.

- Power cables change size at PPB1 and PPF1 from "Type 1" to "Type 2"
- Type 1 is sized for the 1.5m run from inside Pixel Volume to PPB1 through "GAP"
- For B-Layer, this leads to an excessive voltage drop if transition must occur at PPF1
  - Type I is only sized for 1.5m length
- Nominal Drop in type 1& 2 is 0.4V-Type 2 is usually 5.4m long, but for B-Layer is 2.7(+)
  - Propose to Increase Type II cross section slightly and either:
    - Increase Wire sizes to make Type IB @ 0.6V for 3m length (slightly more massive)
    - make a type I cable with length 2.25m (150% length of type 1 cable) to make voltage drop of 0.6V (Introduces auxiliary transition in addition to Patch Panel)

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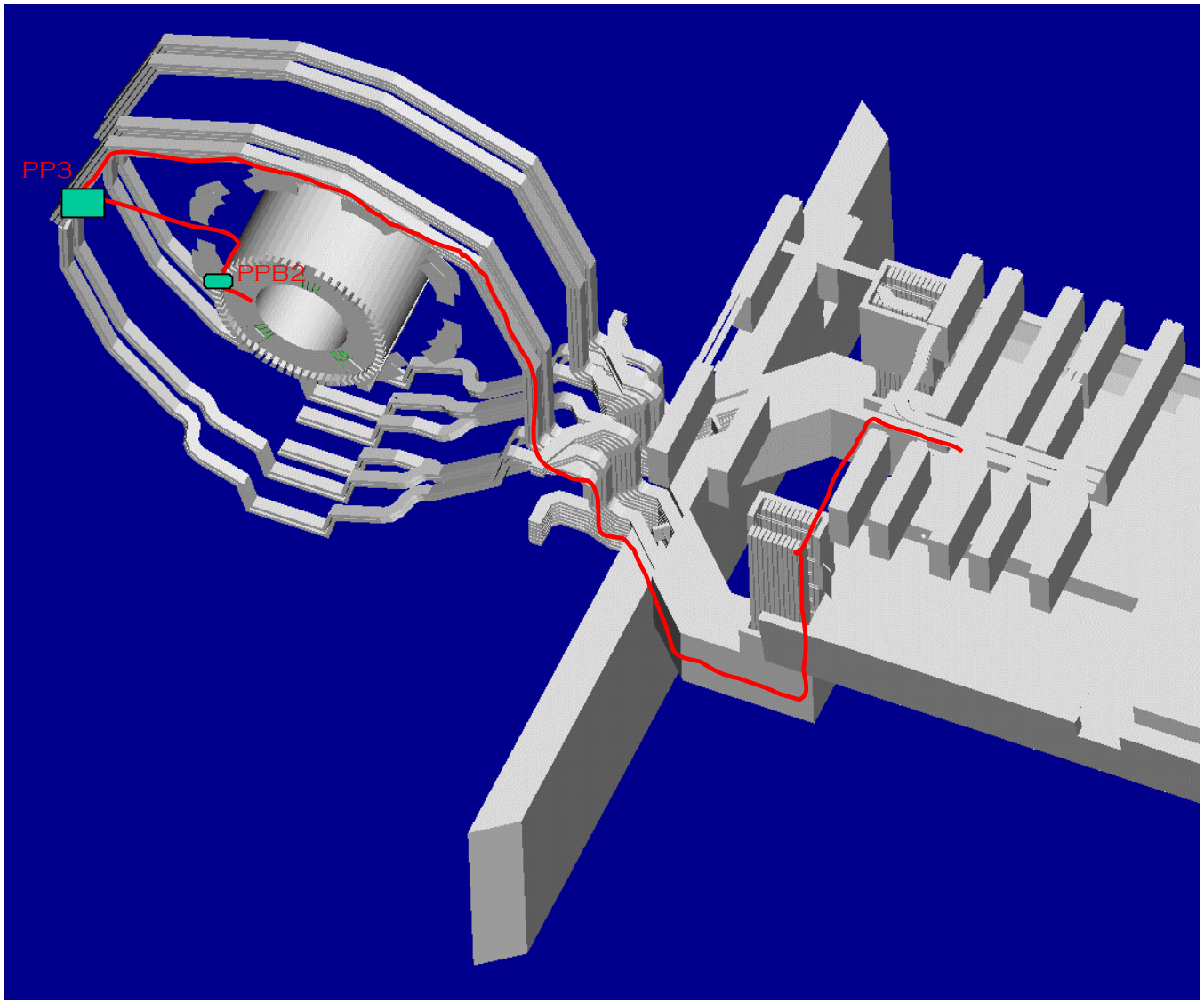
Worst Case Routing to the Racks (USA15)



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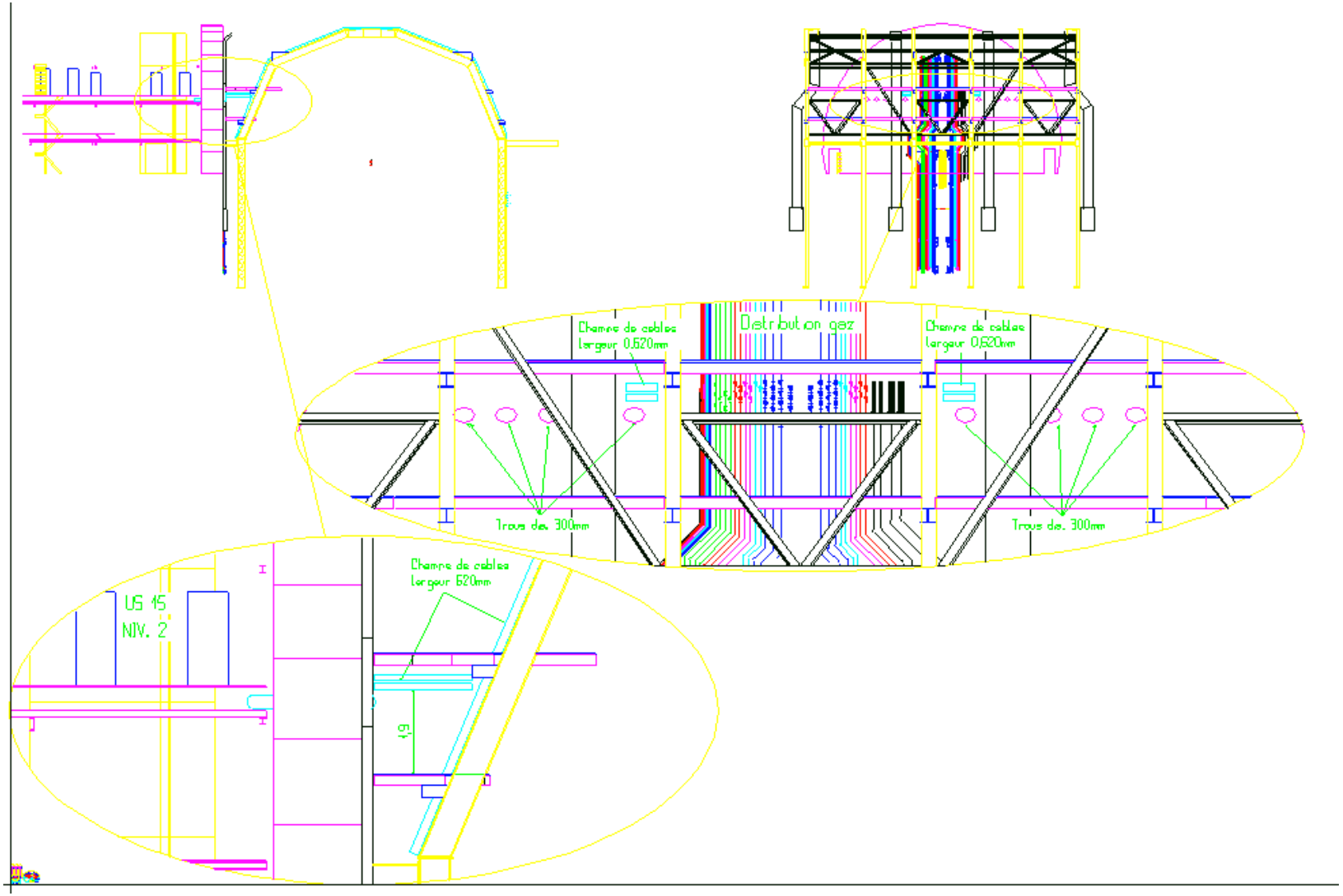
US 15 Elevation



LOW MASS CABLE DEFINITION

TYPE I (7 Module) (ΔV nominal 0.4V/1.5m)

Cable	Circuit Name	Material/ Area for Nom ΔV mm^2	Nearest AWG	Trace Width mm	Conductor Area mm^2	ΔV	quantity	OD or Thickness mm	Width mm	PF = 2 Area mm^2
HV		*Copper Flex*			Cu					
	VDET	-		0.5	0.0125		14	0.10	3.00	8.40
Hi Power		*Aluminum Wire*			Al					
	VDD		26	-	0.1550	0.415	14	1.07	1.07	32.06
	VDDA		26	-	0.1550	0.295	14	1.07	1.07	32.06
	VCC		26	-	0.1550	0.393	14	1.07	1.07	32.06
Low Power		*Copper Flex*			Cu					
	VVDC	-		0.5	0.0125	0.373	14	0.10	1.00	2.80
	VPIN	-		0.5	0.0125	-	14	0.10	1.00	2.80
	ISET0	-		0.5	0.0125	-	14	0.10	1.00	2.80
	ISET1	-		0.5	0.0125	-	14	0.10	1.00	2.80
Flex Foil	*RESET*	-		0.5	0.0125	-	14	0.10	1.00	2.80
0.025	*PT1000 Module*	-		0.5	0.0125	-	14	0.10	1.00	2.80
mm	*PT1000 Cooling*	-		0.5	0.0125	-	0	0.10	1.00	0.00
OPTO		12-way Bundle								
	Fiber bundle			-	-	-	2	0.32	3.06	1.96

TYPE II (7 Module) (ΔV nominal 0.4V/5.4m)

Cable	Circuit Name	Material/ Area for Nom ΔV mm^2	Nearest AWG	Trace Width mm	Conductor Area mm^2	ΔV	quantity	OD or Thickness mm	Width mm	PF = 2 Area mm^2
HV		*Copper Flex*			Cu					
	VDET	-		0.5	0.0125		14	0.10	3.00	8.40
Hi Power		*Aluminum Wire*			Al					
	VDD		20	-	0.6150	0.376	14	1.54	1.54	66.40
	VDDA		20	-	0.6150	0.267	14	1.54	1.54	66.40
	VCC		20	-	0.6150	0.357	14	1.54	1.54	66.40
Low Power		*Copper Flex*			Cu					
	VVDC	-		0.5	0.0125	1.344	14	0.10	1.00	2.80
Flex Foil	*VPIN*	-		0.5	0.0125	-	14	0.10	1.00	2.80
	ISET0	-		0.5	0.0125	-	14	0.10	1.00	2.80
	ISET1	-		0.5	0.0125	-	14	0.10	1.00	2.80
	RESET	-		0.5	0.0125	-	14	0.10	1.00	2.80
0.025	*PT1000 Module*	-		0.5	0.0125	-	14	0.10	1.00	2.80
mm	*PT1000 Cooling*	-		0.5	0.0125	-	0	0.10	1.00	0.00
OPTO		12-way Bundle								
	Fiber bundle			-	-	-	2	0.32	3.06	1.96

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Conventional Cables

TYPE III (7 Module) (ΔV nominal 0.25V/20m)

Cable	Circuit Name	Material/ Area for Nom ΔV mm^2	Nearest AWG	Trace Width mm	Conductor Area mm^2	ΔV	quantity	OD or Thickness mm	Width mm	PF = 2 Area mm^2
HV		*Copper Wire*			Cu					
	VDET	-					7	1.00	1.00	14.00
Hi Power		*Copper Wire*			Cu					
	VDD		14	-	1.9300	0.272	14	2.39	2.39	159.94
	VDDA		16	-	1.2300	0.303	14	1.94	1.94	105.38
	VCC		14	-	1.9300	0.258	14	2.39	2.39	159.94
	VVDC		16	-	1.2300	0.051	14	1.94	1.94	105.38
Low Power		*Copper Wire*			Cu					
	VPIN	-	30	-		-	14	0.31	0.31	2.60
	SENSE	-	30	-		-	42	0.31	0.31	7.81
	ISET0	-	30	-		-	14	0.31	0.31	2.60
	ISET1	-	30	-		-	14	0.31	0.31	2.60
	RESET	-	30	-		-	14	0.31	0.31	2.60
	PT1000 Module	-	30	-		-	14	0.31	0.31	2.60
	PT1000 Cooling	-	30	-		-	0	0.31	0.31	0.00
OPTO		12-way Bundle								
	Fiber bundle			-	-	-	2	0.32	3.06	1.96

TYPE IV (7 Module) (ΔV nominal 0.50V/100m)

Cable	Circuit Name	Material/ Area for Nom ΔV mm^2	Nearest AWG	Trace Width mm	Conductor Area mm^2	ΔV	quantity	OD or Thickness mm	Width mm	PF = 2 Area mm^2
HV		*Copper Wire*			Cu					
	VDET	-					7	1.00	1.00	14.00
Hi Power		*Copper Wire*			Cu					
	VDD		10	-	4.7400	0.554	14	3.51	3.51	344.96
	VDDA		12	-	2.9800	0.626	14	2.86	2.86	229.03
	VCC		10	-	4.7400	0.525	14	3.51	3.51	344.96
	VVDC		12	-	2.9800	0.104	14	2.86	2.86	229.03
Low Power		*Copper Wire*			Cu					
	VPIN	-	30	-		-	14	0.31	0.31	2.60
	SENSE	-	30	-		-	42	0.31	0.31	7.81
	ISET0	-	30	-		-	14	0.31	0.31	2.60
	ISET1	-	30	-		-	14	0.31	0.31	2.60
	RESET	-	30	-		-	14	0.31	0.31	2.60
	PT1000 Module	-	30	-		-	14	0.31	0.31	2.60
	PT1000 Cooling	-	30	-		-	0	0.31	0.31	0.00
OPTO		12-way Bundle								
	Fiber bundle			-	-	-	2	0.32	3.06	1.96

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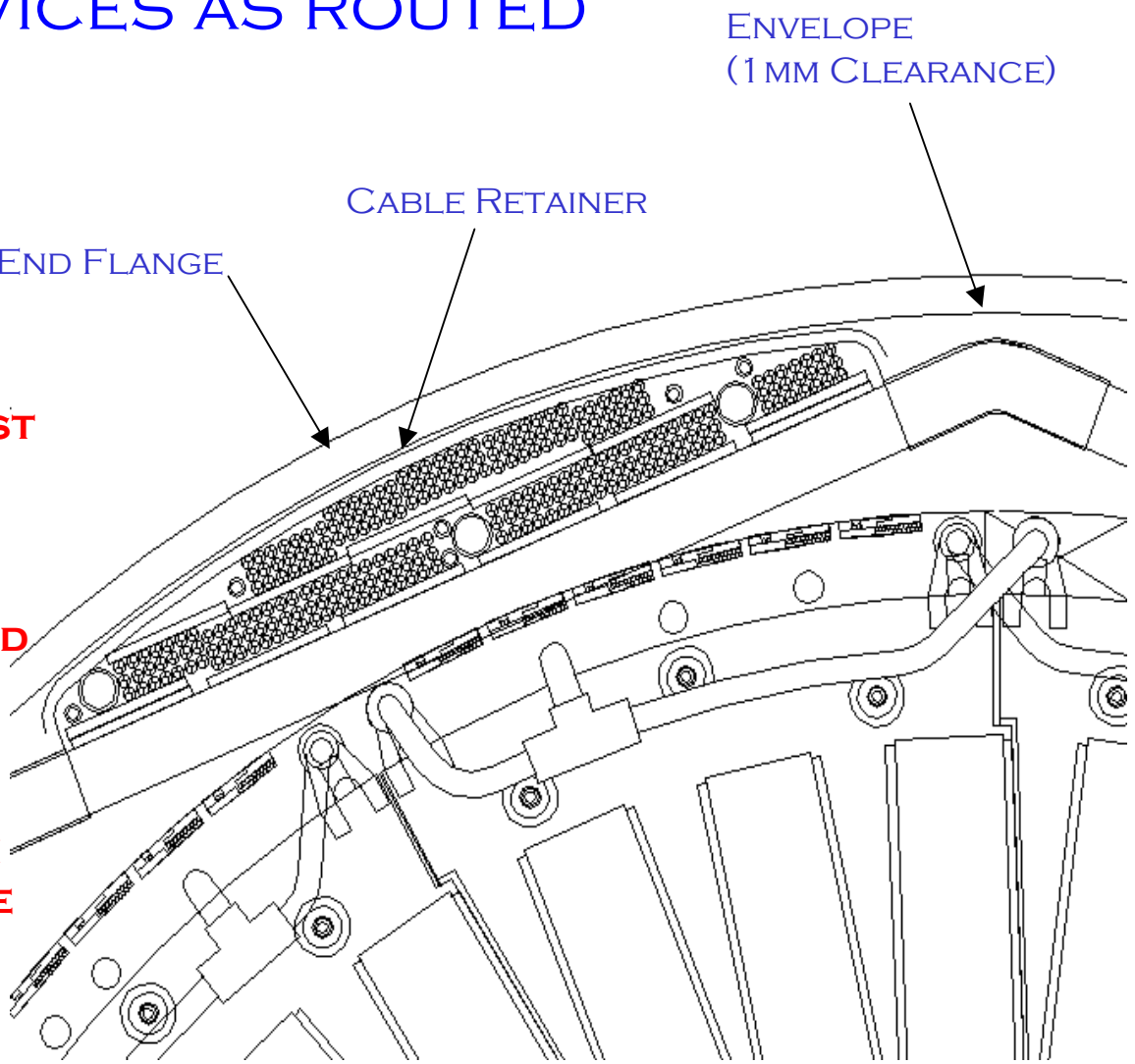
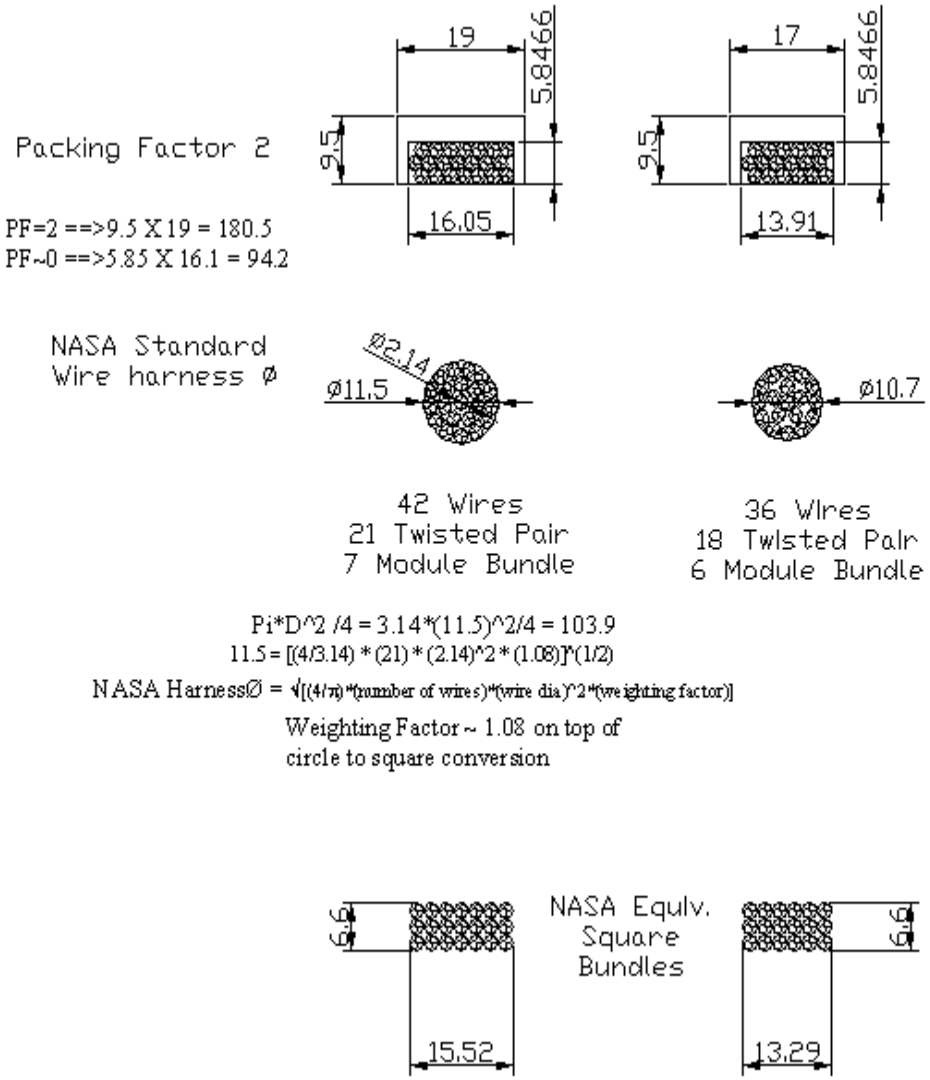
Services as routed



- From CAD models with twisted pair sized for worst case power, we are near limit of space available
- Exit of barrel services from interior of frame need close attention and physical model to assess real space
- Increases in Cross Section from this case is untenable space-wise
- flex cables from wire represents backup sol'n

Packing Factor vs. Space Available



- We should standardize on a way to size cable bundles so that quoted numbers are meaningful within ID
- Bundles should be sized and free space quoted
- Packing Factors are more appropriate for building construction than satellite construction-they are used for circular conduit and fire codes
- Propose This as an alternative

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Cable Prototyping

- **LBNL to provide all prototypes for Pixel Cable**
- **Propose:**
  - Provide Single Module Cables at first
    - Bring Power (only) in on long cables-leave control signals and Vvdc to iteration with flex cables
    - Test twisted and non-twisted cable performance, possibly in simulated noise environment
  - Rebuild infrastructure to make large Flex (For end of Oct)
    - Make single module realistic cables with power and control signals (including optical link)-Round + Flex Solution & Flex/Flex if desired
    - intended for iteration of module with optolink on board
  - <<Check point>> Decide what cable option set to pursue (Jan '00)
  - Make Full length Cable Bundles for Spring '00
    - Multiple Module
    - Pigtail designs need to proceed along similar lines
    - Need to check integration with Flex-Hybrid phasing/schedule
    - Represents significant mismatch with proposed ID Mockup

Pixel Detector

6 meter Exposure table

- 6 meters full aperture
- 30cm width
- Situated in flex circuit processing lab allowing for exposure, development, etch, QA and touchup in same building
- Running behind ~4wks due to late start
- Still within budget

Table will be complete prior to end of September, when Tech must shift effort to BaBar. At this time Circuit fab shop will qualify the machine production parameters

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Pigtail Prototype Testing

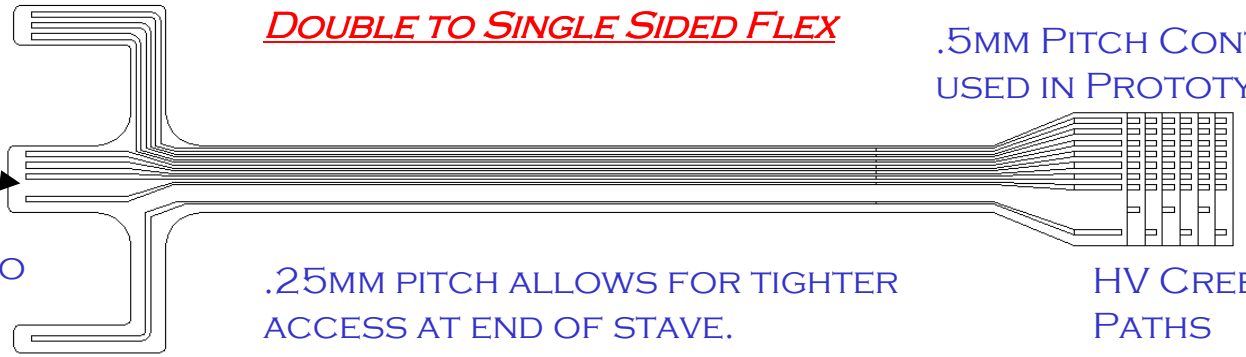
There are 7 layers in this Flex-Circuit

NOT PIGTAIL TO MODULE CONNECTION

Double to Single Sided Flex

.5mm Pitch Contact used in Prototype

Double sided cable Attaches here

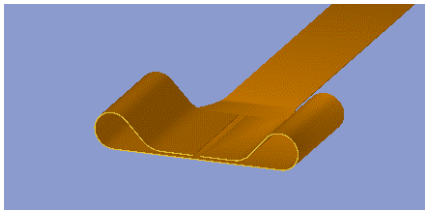


Arms fold over to pick up top

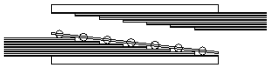
HV

.25mm pitch allows for tighter access at end of stave.

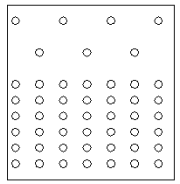
HV Creep Paths



Up to 90 connections must be made at each end of every stave

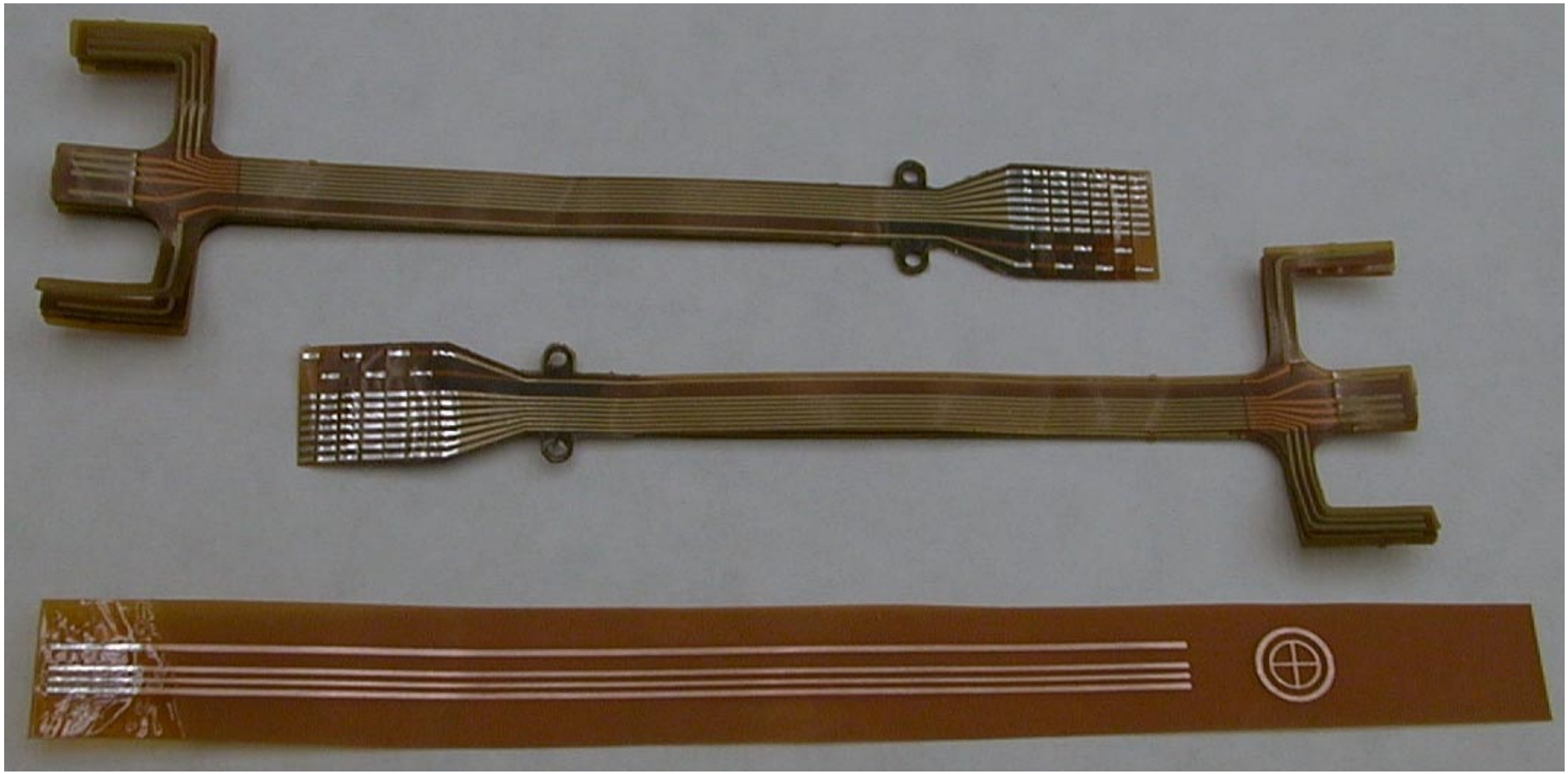


Ball Grid Array Contact Pad

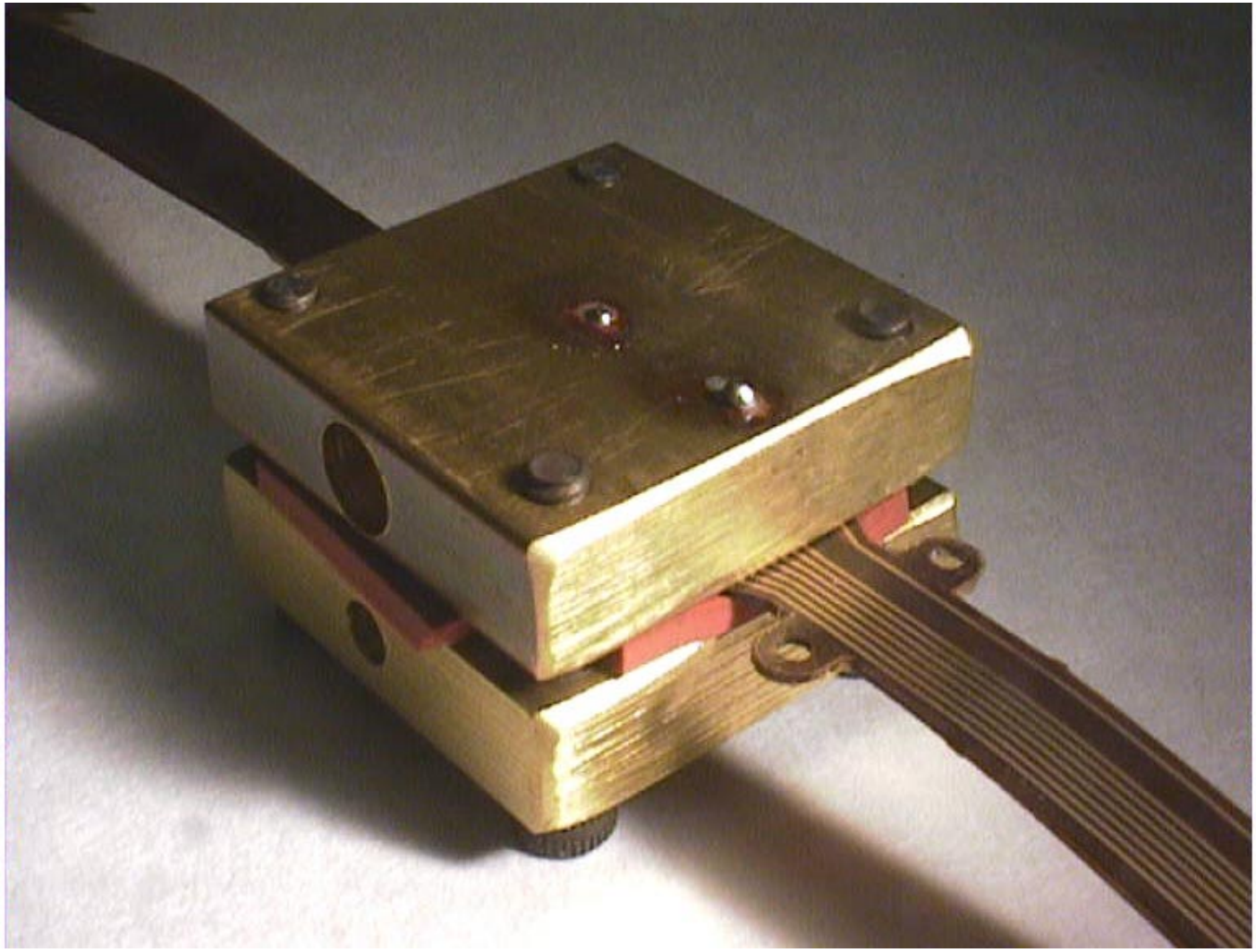


- **Test Assembling Solder End**
  - Oxford has successfully soldered 0.5mm pitch straight cable
  - Testing array technique at LBNL
- **More interested in Multi-Layer array connection**
- **Have similar concept for terminating to module flex**
  - Prototype artwork

Prototype Array Connectors



Solder Block w/Pressure Pad



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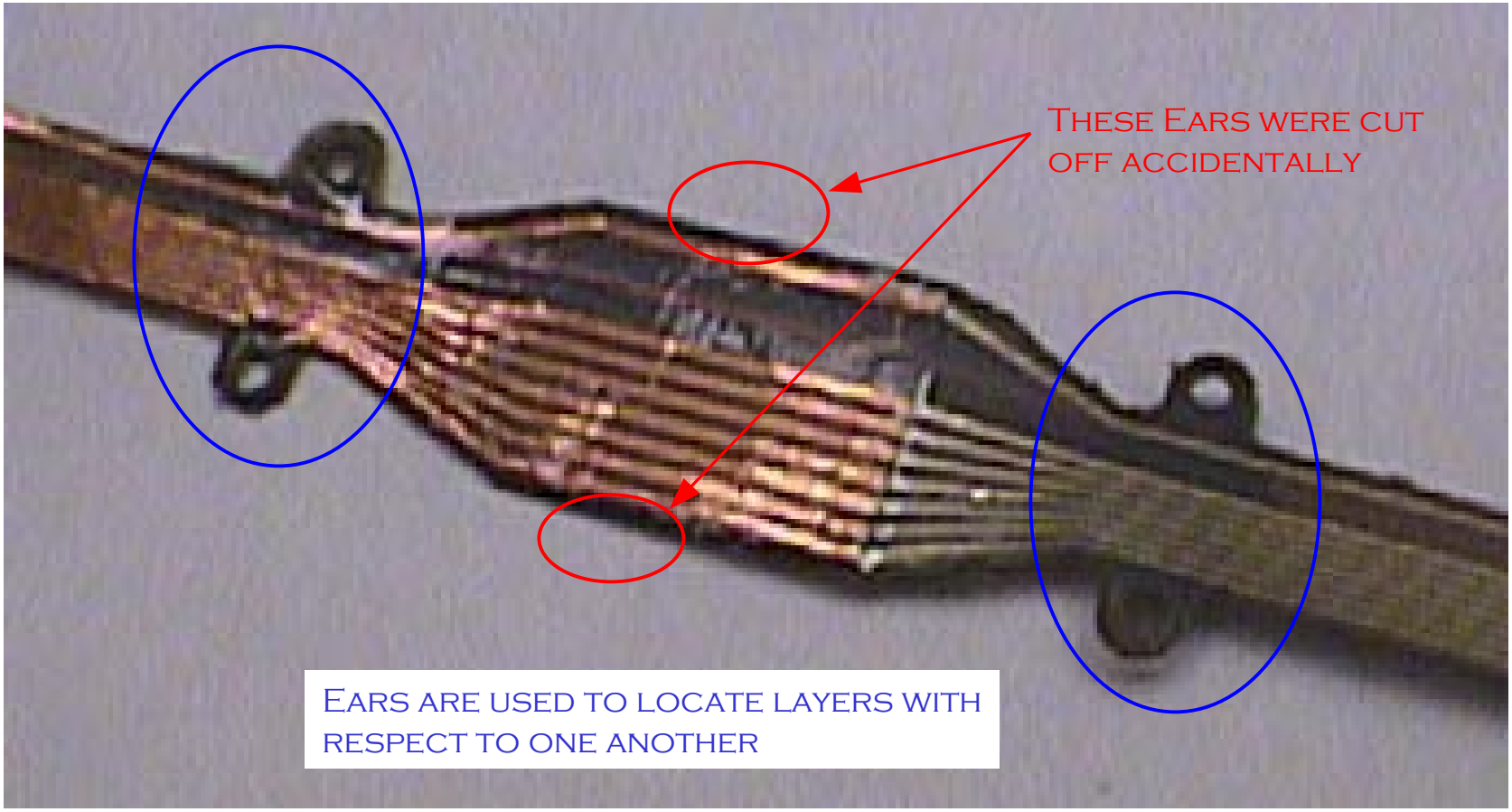
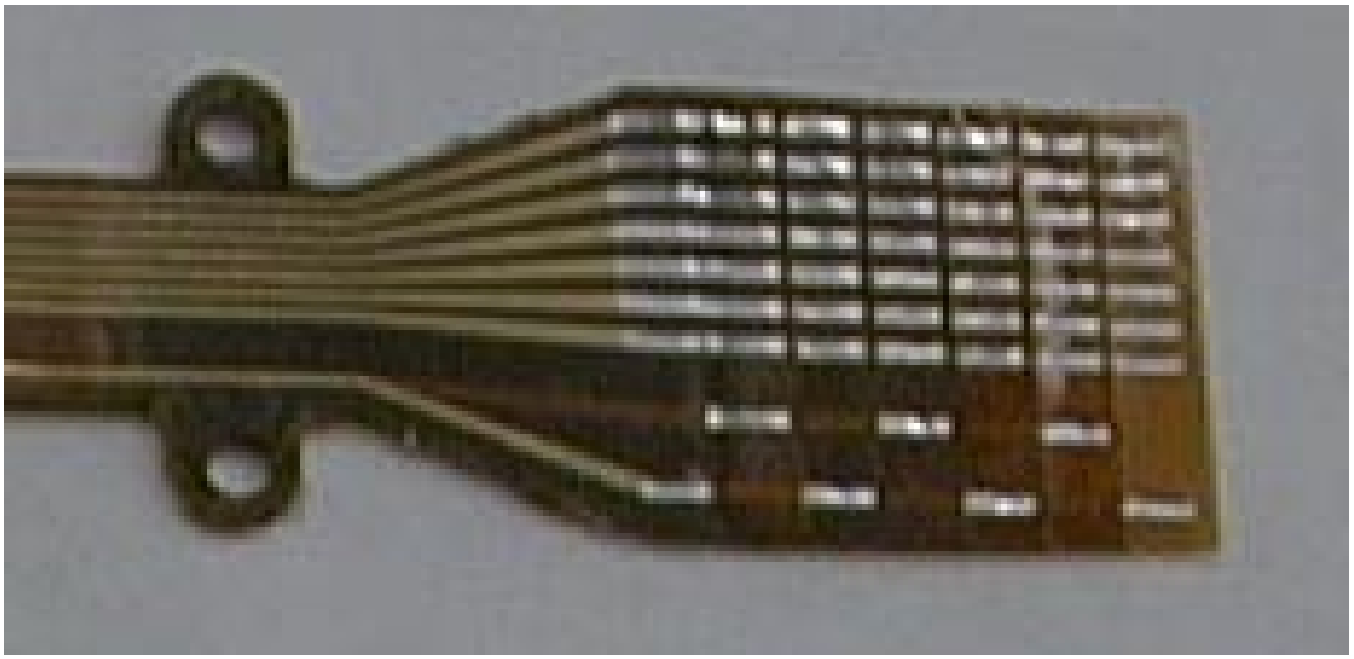
Finished Connection



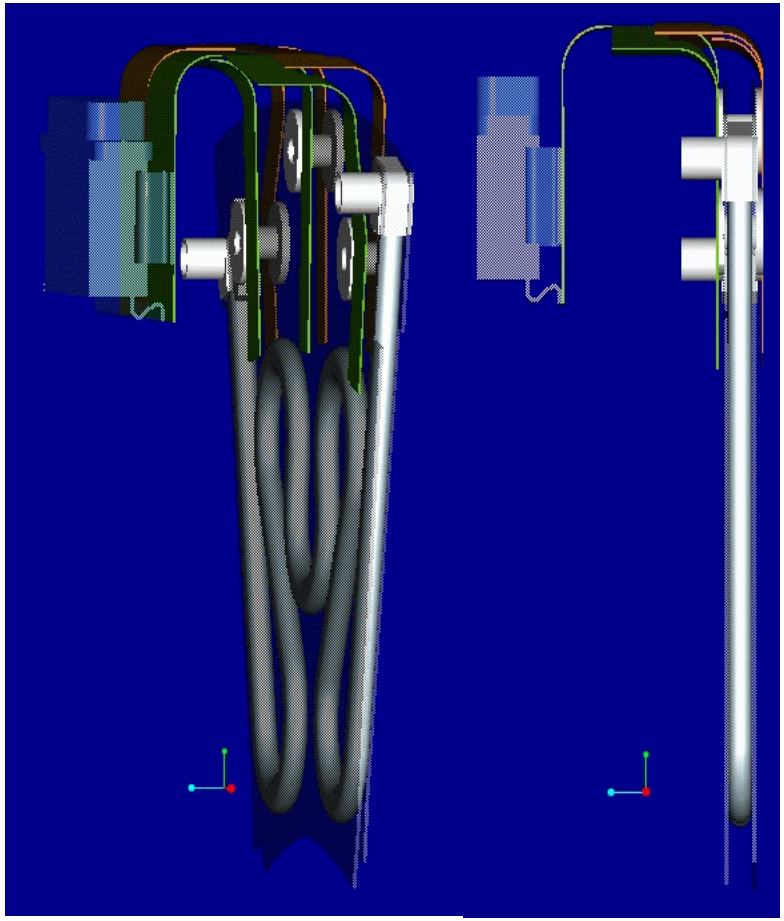
- **Blind Alignment was difficult due to a manufacturing error**
  - On part alignment was better than 25micron using these ears
  - Mating tolerance should be similar

Bridging of Different Layers



- **Edge Trim of Kapton standoff area is too small**
  - Easily fixed
- **Must be careful of wicking in step corners**
  - not a problem if the glue line is adequate
- **Need to control volume of solder**
  - First try dipped both into solder bath--no control whatever

Physical Integration of Terminations



- **Want to minimize part-count per bundle--integrate all pigtails into one multi-layer flex**
- **Reducing Number of Connectors**
  - Reduces Space at Patch Panels
  - Reduces Time for maintenance
  - Matches Structural Modularity
  - Requires alternate way of testing individual Modules
  - Increases expense of pigtail (?)
- **Take advantage of accuracy of Flex-Circuit production as larger integrating structure**
  - Discuss migration of components from hybrid to pigtail?
  - Possible layout advantages in Barrel
  - Opto-electrical Harness (like SCT)?

Questions to Answer (within Pixels)

- **Immediate**
  - Number of circuits
  - Is Philosophy acceptable (as opposed to local regulation)–?
- **Not so immediate (6 months)**
  - Flat vs. Round–Awaits Prototyping
  - Grounding and Shielding of cables–Mono-Ground?
  - Voltage budget vs Cost/Space
  - Possibility of rad hard voltage regulation at PPB2–Proposal by CAEN
- **Beyond Prototype Cables (+6 months)**
  - Patch Panel Design (inclusion of passive components)
    - circuit board layout
  - Number/type/size of non-module services–Generate Service Inventory
    - Grounding
    - Shielding
    - Heaters
    - DCS sensors that aren't related to modules (e.g. services temp)
    - Cooling Sensors
    - ROD stuffs

Quick look at cooling

- **Tubing Sizes are not fully understood, but pushed as large as ID would tolerate**
  - Inner Diameters of 7, 9 and 13, to PP1, PP2, and PP3 resp.
- **Number of circuits is likely to change soon**
  - Laid into ID service layout as single capillary per structure, with manifolded exhaust
  - Possible change from parallel to series
- **No fitting for PP1 or lower currently meets the ground rules, ie no O-rings, and a standard fitting**
  - Will propose swagelok equivalent fitting for PP1
  - Have no solution for pixel volume-implies developing a fitting
- **Need to home in on a cooling rig design to properly size service plant**
  - Change of Coolant may yield smaller tube diameters
  - Have acquired Rack allocation on service platforms for cooling racks.

Open discussion of ID Service Mockup

- **Scope**
  - To model up to 1/4 section of the tracker service bundle up to PP2
  - Model PP1 and PP2
  - Assure that service routing is viable
- **Location**
  - To be located at CERN, likely building 186
  - Parts of ID barrel mock-up shipped from RAL to CERN
- **Responsibilities**
  - TC Provides Cryostat model and PP2 Region
  - ID provides layouts, and "common items"
  - Subsystems provide their own connectors, and contribute to ID for common items
- **What do we do?**
  - Discussion/Questions